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NARRAGANSETT BAY COMMISSION REHABILITATION OF LARGE DIAMETER BRICK SEWER WITH GEOSPRAY GEOPOLYMER MORTAR

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NASTT's 2019 No-Dig Show



Route 6 & 10 Connector – NBC Interceptor Rehabilitation

Project Details:

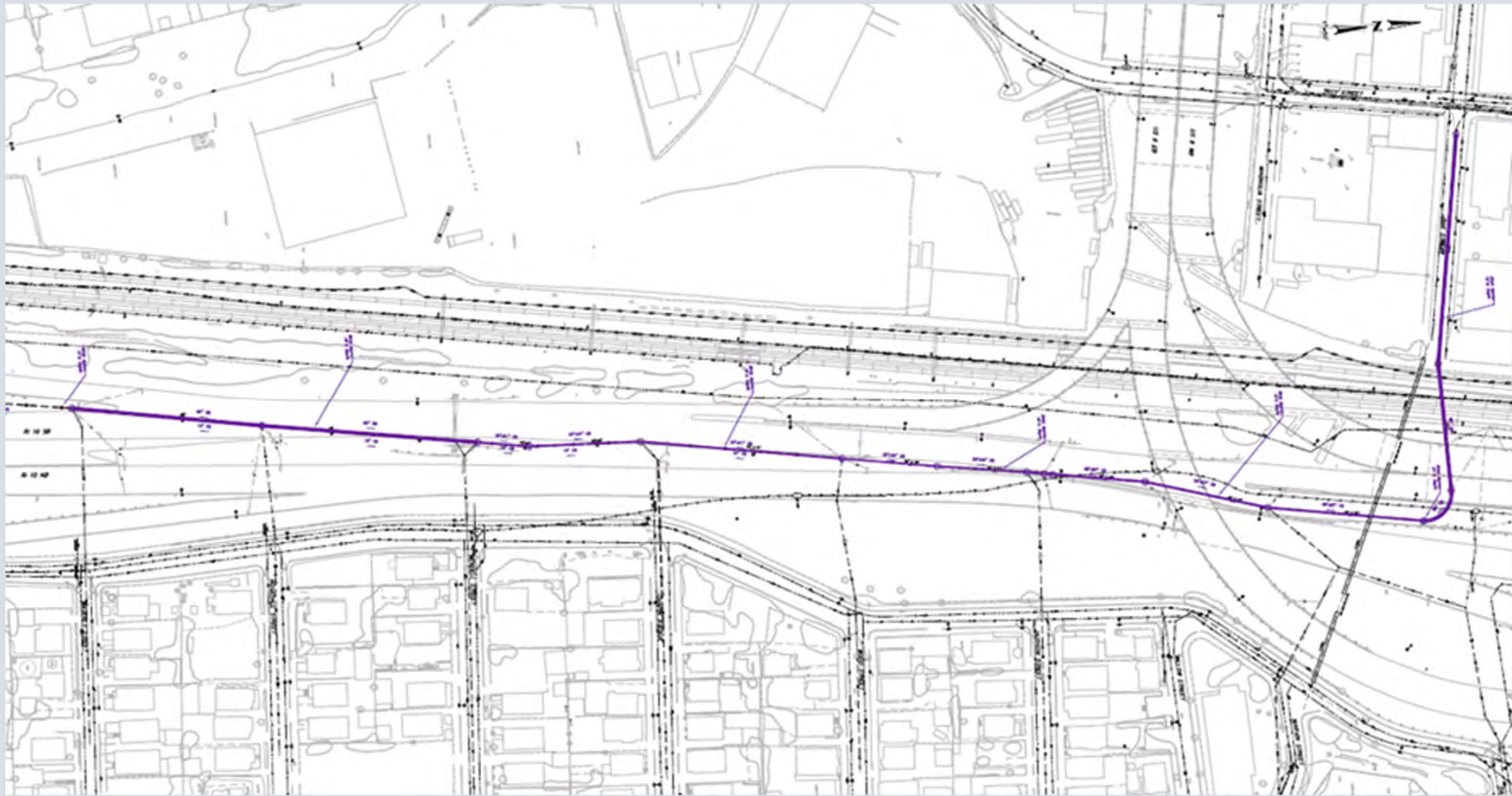
- Owner / Designer – Narragansett Bay Commission
- 2,430 feet of large diameter brick sewer up to 60"
- The Route 6 & 10 Connector built on top of the sewer interceptor
- Various defects within brick pipes creating high level of infiltration and structural defects
- Repaired with GeoSpray geopolymer from Milliken Infrastructure
- Contractor Installer – National Water Main Cleaning



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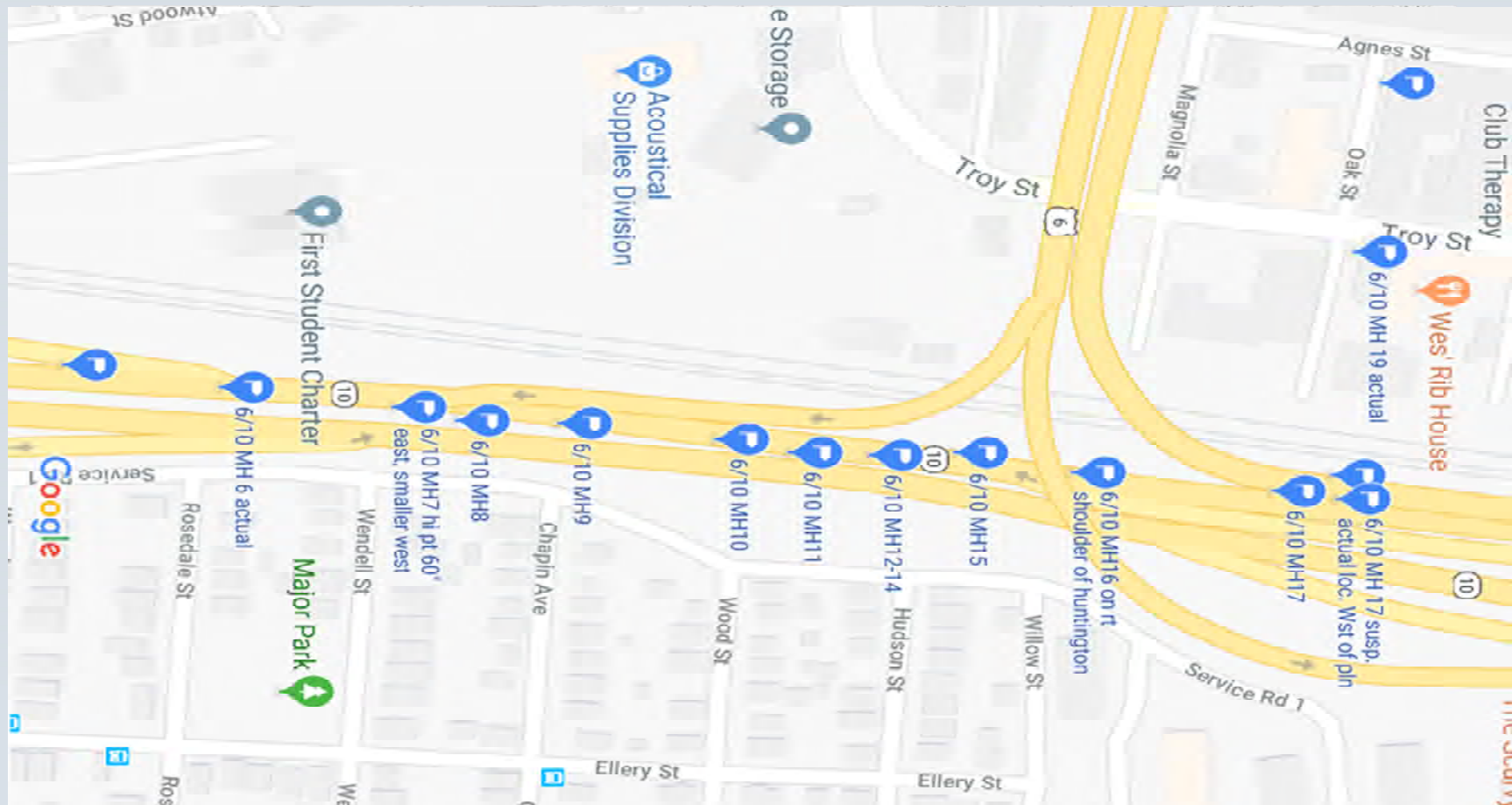
Project Location – RT 6 & 10 Connector



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Project Location – RT 6 & 10 Connector



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PIPE DEFECTS



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Lining Options Considered

- Cured in Place Pipe (CIPP)
 - 60" liner required MH removal, repaving and traffic redirection
 - Over hole wet out large construction footprint not desired
 - Construction not possible at transition in pipe diameter
 - Concerns over fins and folds causing obstructions
- Slip Line
 - Similar to CIPP, the desire was to avoid MH removal or insertion pits; Significant capacity reduction
- Dig and Replace
 - Pipe depth and location under the highway made it too \$\$\$
- Centrifugally Cast Concrete Pipe (CCCP)
 - Portland cement material concerns on water intrusion and desired corrosion protection
- Spin Cast Geopolymer Pipe (SCGP)
 - Selected for stopping infiltration, small footprint, no excavation, no lane closure, corrosion protection, longevity, less bypass required



SCGP Liner Design (6 methods to pick from)

- Distributed Beam Load over a Partial Ring Model

$$t = \sqrt{\frac{0.0744 Q_T r^2}{S_F} \frac{N}{c}}$$

t = Minimum Liner Thickness, inches

Q_t = Total External Load as calculated from ASTM F 1216-09 for fully deteriorate pipe

r = Radius of the interior crown of the pipe or ½ the largest interior horizontal dimension, inches

N = Safety Factor = 2

S_F = The 28 day Flexural Strength (or Modulus of Rupture) as determined by ASTM C78, psi.

c = Ovality Reduction Factor as defined in ASTM F 1216-09

- 10-17 feet crown cover assume water at surface
 - 30" x 45" & 38" x 57" Vertical Ellipse & 60" Round Brick Pipe
 - 50 plus years
 - AASHTO HS 25 and E80 Rail
- Result: $t = 1"$ for smaller pipes and $1.5"$ for 60" Pipe
(based on ASTM C78 Flexural Strength = 1500 psi)

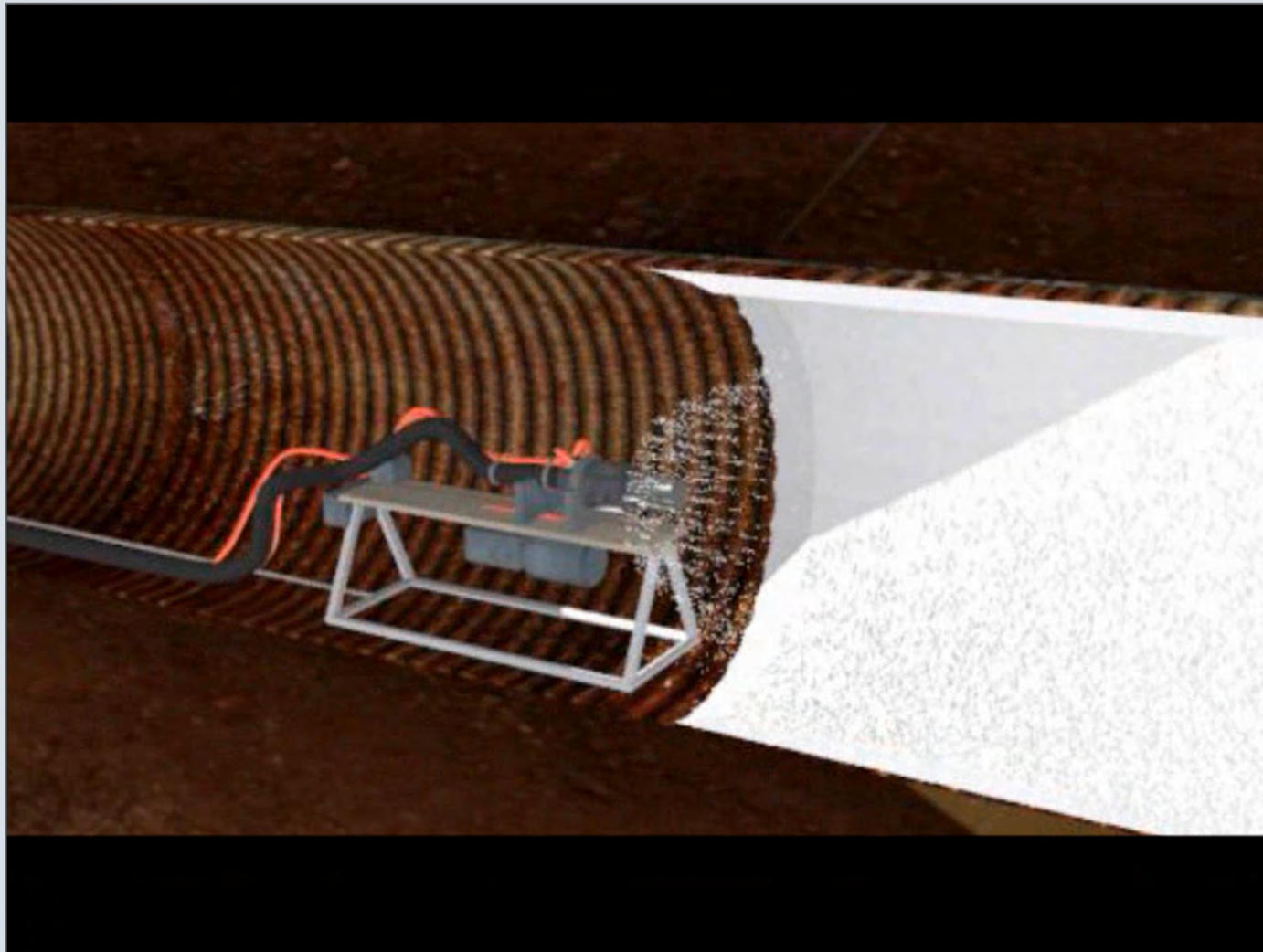


What is a Geopolymer?

- Not a Plastic
 - Not HDPE/PVC/Epoxy
- Looks and feels like cement
 - Workability
 - Material Properties
 - Service Life
- Chemical structure like natural stone
 - Monolithic
 - Durable
 - Corrosion Resistant



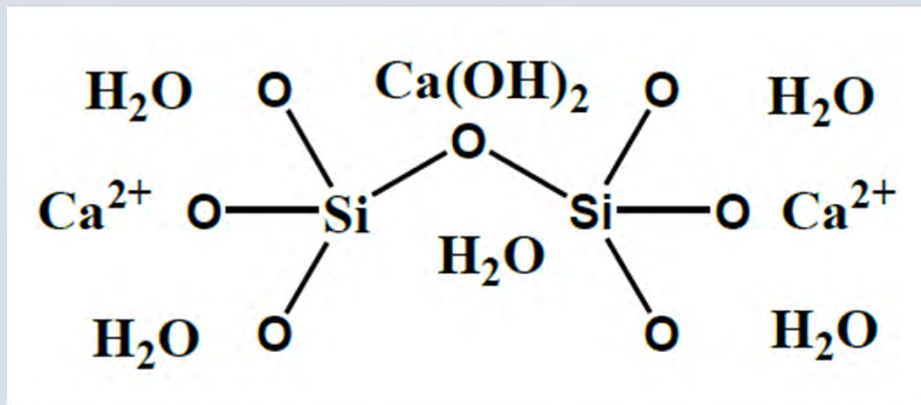
Spin Casting Geopolymer Pipe (SCGP) Process



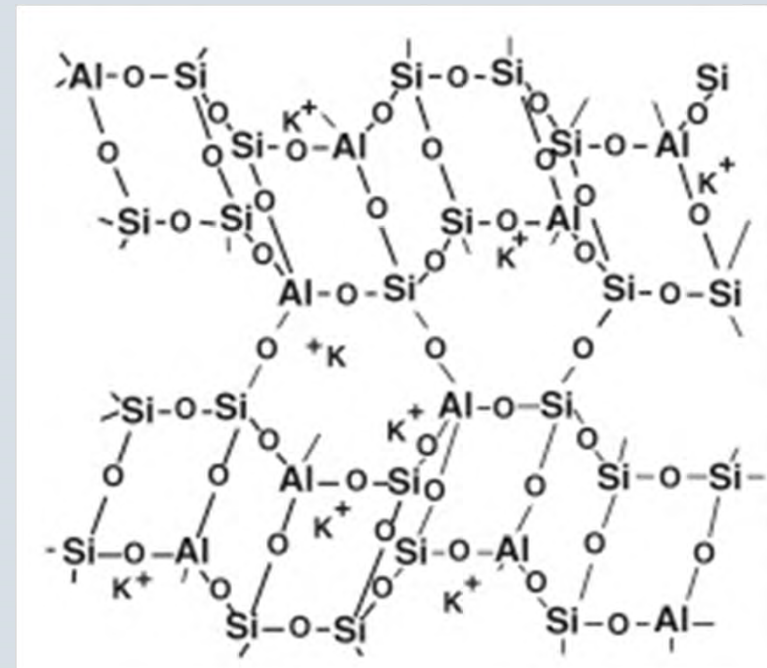
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Geopolymer Chemistry Primer



Typical Hydrated OPC Structure



Typical Geopolymer Structure



Cold Joints

Experimental Parameters:

- On the first day a series of 2" by 4" cylinders were cast half full and cured with an approximately 45 degree angle
- On subsequent days (1, 7, 14 and 28) the top half of the cylinders were cast and filled creating a 45° angled joint in the center of the cylinders
- Compressive strength tests were conducted 28 days after the top half of the cylinders were cast



Joint in Tested
Sample



Cold Joints – Testing Data

Results:

- Samples cast of GeoSpray Geopolymer (both halves) when tested under compression did not break at the joint
- The chemical nature of GeoSpray allows for chemical bonding across the interface even with pours 28 days apart resulting in a monolithic structure
- Samples cast of competitive cement mortars always broke along the angled joint essentially creating 2 separate layers

GeoSpray geopolymer



Portland Based Material



Day 0

Day 1

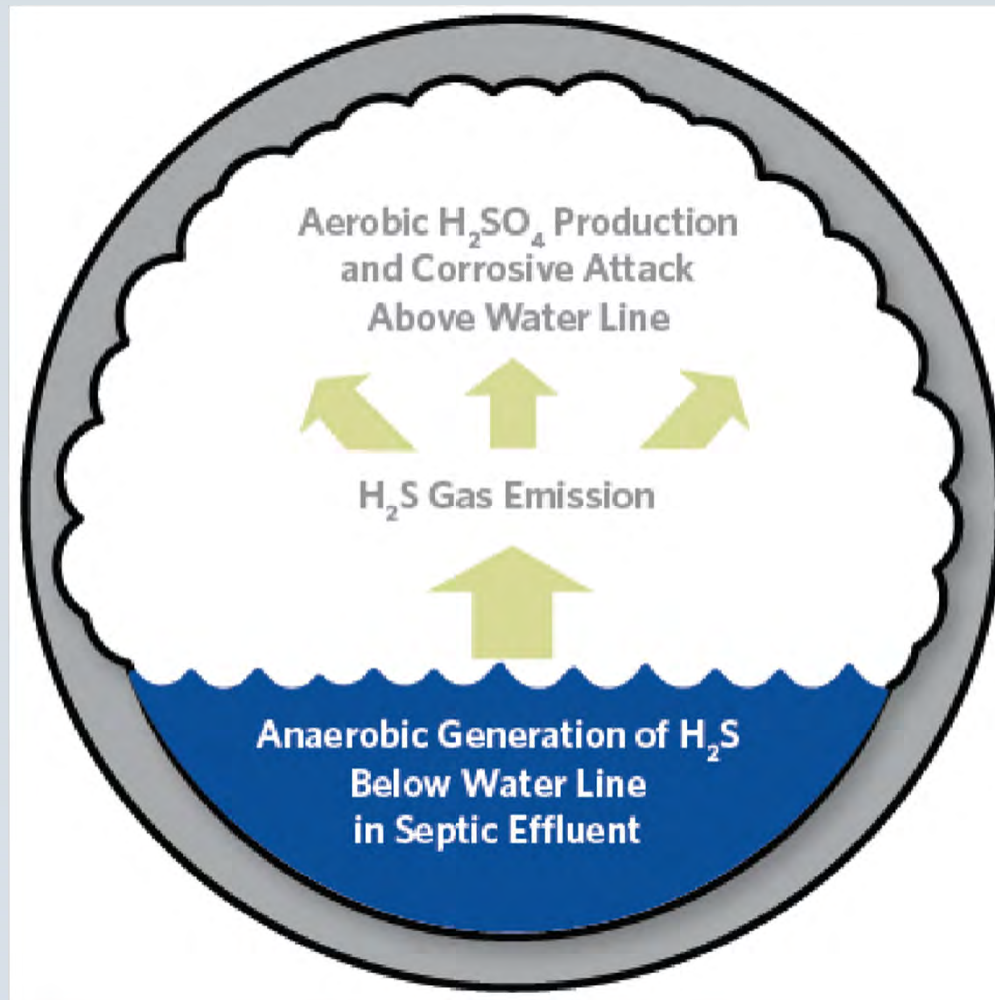
Day 7

Day 14

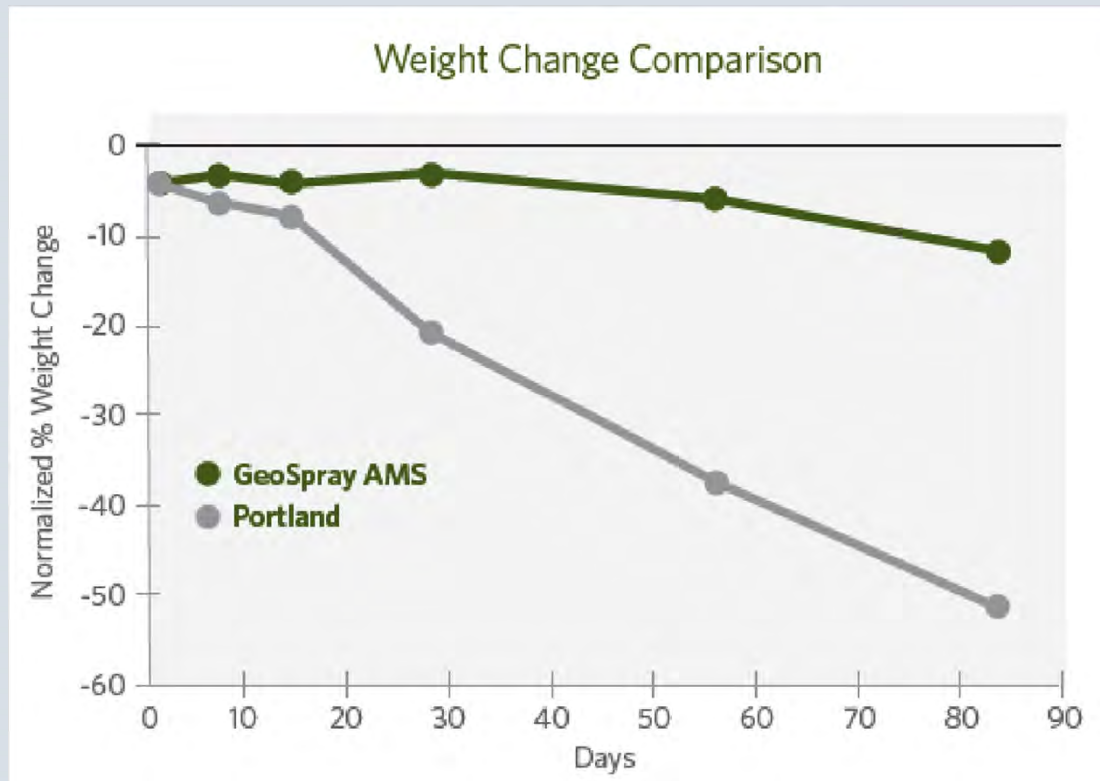
Day 28



Microbial Induced Corrosion (MIC) Mechanism



Geopolymer Advantage – Corrosion Protection



Independent Testing and Analysis

EPA Evaluation:

- U.S. Environmental Protection Agency developed an innovative technology demonstration program to evaluate technologies that have potential to reduce costs and increase the effectiveness of the operation, maintenance and renewal of aging water distribution and wastewater collection systems
- The EPA observed and monitored this project as part of this program



See www2.epa.gov/water-research (search Geopolymer)



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NWMCC SCGP – Small Construction Footprint



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NWMCC SCGP – Small Construction Footprint



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Construction Footprint / Pipe Access



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INFILTRATION ISSUES



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Crown Repair & Infiltration Control



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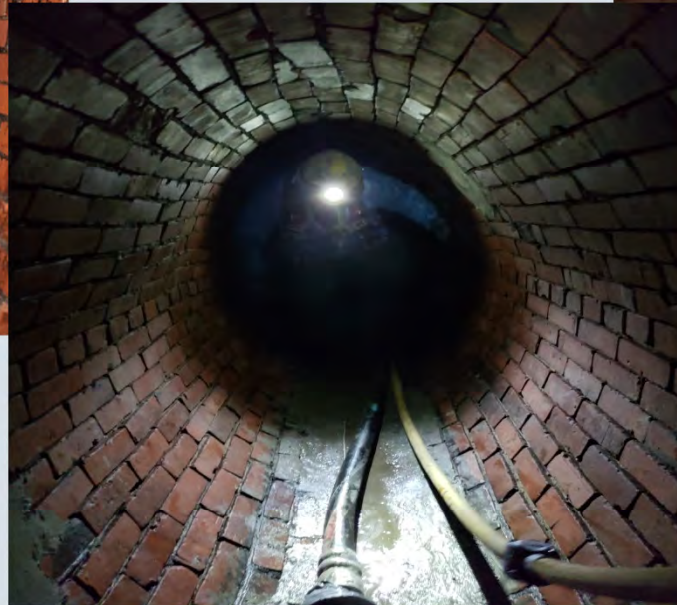
Liner Thickness / Depth Gauges



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Various Pipe Sizes of Rehab



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Pipe Rehabilitation

Application of First Layer and Final Layer



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Internal Bypass SCGP Through 90 Degree Bend



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Completed Structure



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Challenges and Lessons Learned

- No National ASTM Design Standard Exists
 - Counting FEM there are 6 minimum design methods
 - 2" of SCGP \neq 2" of CCCP \neq 2" Portland Concrete
- Mobilization & Demobilization
 - Evaluate leaving equipment and barricades in place during day
 - Getting tractor trailer with GeoSpray in and unloaded in median
- Wet Weather Go / No Go Decision
 - Old CIPP rule - if chance of rain at 5 AM, scrub work
 - New – with geopolymer NBC let NWMCC decide to work or not
- Four Season Liner
 - Geopolymer is more resilient in hot cold and wet weather, so Geopolymer is a new tool for NBC on future projects



Thank You & Questions?

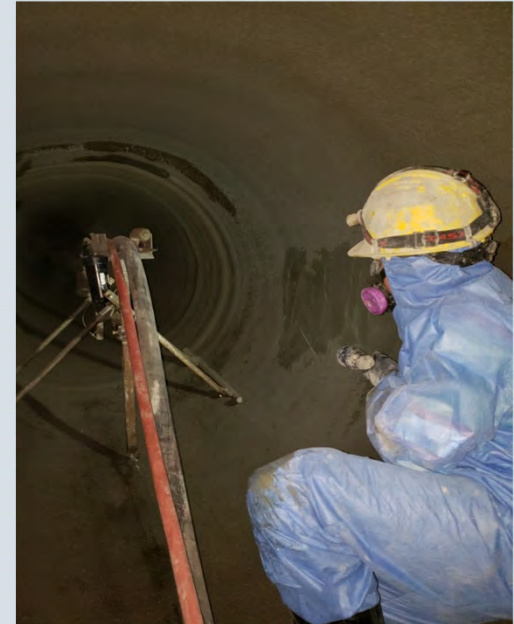
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